What is claimed is:

1.   A method of recovery in an asynchronous remote copy system having a primary file system at a primary site and a secondary file system at a secondary site, said method comprising:

in response to the primary site becoming inoperative during read/write access to the primary file system and asynchronous remote copy of changes made to the primary file system being copied to the secondary file system, beginning read/write access to the secondary file system, making a snapshot copy of the secondary file system at the beginning of read/write access to the secondary file system, and keeping a record of changes made to the secondary file system during the read/write access to the secondary file system; and thereafter,

when the primary site becomes operative, using the snapshot copy to restore the primary file system to the state of the secondary file system existing when read/write access of the secondary file system was begun, and then writing into the primary file system the changes made to the secondary file system during the read/write access to the secondary file system; and

terminating read/write access to the secondary file system, and once the changes made to the secondary file system have been written into the primary file system, restarting read/write access to the primary file system and asynchronous remote copy of changes made to the primary file system being copied to the secondary file system.

2.	The method as claimed in claim 1, wherein the asynchronous remote copy of changes made to the primary file system being copied to the secondary file system includes using the Internet Protocol to transmit the changes made to the primary file system over a data network between the primary site and the secondary site.

3.	The method as claimed in claim 2, which includes, in response to the primary site becoming operative, transmitting over a first IP pipe changes having been made to the secondary file system during the read/write access to the secondary file system prior to the primary site becoming operative, and concurrently transmitting over a second IP pipe changes having been made to the secondary file system during read/write access to the secondary file system after the primary site becomes operative.

4.	The method as claimed in claim 1, wherein the state of the secondary file system existing when read/write access of the secondary file system was begun is a prior state of the primary file system existing before the primary site became inoperative, and the method includes the primary site keeping a list of blocks that have been changed in the primary file system during read/write access to the primary file system, and the snapshot copy is used to restore the primary file system to the state of the secondary file system existing when read/write access of the secondary file system was begun by accessing the list of blocks that have been changed in the primary file system during the read/write access to the primary file system to determine the blocks that have been changed in the primary file system since said prior state of the primary file system, and

1   copying from the snapshot copy to the primary file system the blocks that have been

2   changed in the primary file system since said prior state of the primary file system.

3

4   5.   A method of recovery in an asynchronous remote copy system having a

5   primary file system at a primary site and a secondary file system at a secondary site, said

6   method comprising:

7   in response to the primary site becoming inoperative during the asynchronous

8   remote copy of changes made to the primary file system being copied to the secondary

9   file system, beginning read/write access to the secondary file system, and then:

10   in response to the primary site becoming operative, synchronizing the primary file

11   system to the secondary file system by beginning asynchronous remote copy of changes

12   made to the secondary file system being copied to the primary file system, making a

13   snapshot copy of the secondary file system at the beginning of the asynchronous remote

14   copy of changes made to the secondary file system being copied to the primary file

15   system, synchronizing the primary file system to the snapshot copy of the secondary file

16   system, and once the primary file system has been synchronized to the snapshot copy of

17   the secondary file system, terminating read/write access to the secondary file system and

18   completing the asynchronous remote copy of changes made to the secondary file system

19   being copied to the primary file system; and

20   once the asynchronous remote copy of changes made to the secondary file system

21   has been completed, restarting the read/write access to the primary file system and

22   asynchronous remote copy of changes made to the primary file system being copied to

23   the secondary file system.

6.   The method as claimed in claim 5, wherein the asynchronous remote copy of changes made to the primary file system being copied to the secondary file system includes using the Internet Protocol to transmit the changes made to the primary file system over a data network between the primary site and the secondary site.

7.   The method as claimed in claim 5, wherein the asynchronous remote copy of changes made to the secondary file system being copied to the primary file system includes transmitting changes made to the secondary file system over a first IP pipe from the secondary site to the primary site, and the synchronizing of the primary file system to the snapshot copy of the secondary file system includes transmitting changes made to the secondary file system over a second IP pipe from the secondary site to the primary site, and wherein the transmission of the changes made to the secondary file system over the first IP pipe is concurrent with the transmission of the changes made to the secondary file system over the second IP pipe.

8.   A method of recovery in an asynchronous remote copy system having a primary file system at a primary site and a secondary file system at a secondary site, said method comprising:

in response to the primary site becoming inoperative during read/write access to the primary file system and asynchronous remote copy of changes made to the primary file system being copied to the secondary file system, beginning read/write access to the secondary file system, making a first snapshot copy of the secondary file system at the

1 beginning of read/write access to the secondary file system, and keeping a record of

2 changes made to the secondary file system during the read/write access to the secondary

3 file system; and thereafter,

4   when the primary site becomes operative, making a second snapshot copy of the

5 secondary file system, beginning asynchronous remote copy of changes made to the

6 secondary file system since the second snapshot copy being copied to the primary file

7 system, using the first snapshot copy to restore the primary file system to the state of the

8 secondary file system existing when read/write access of the secondary file system was

9 begun, and then writing into the primary file system the changes made to the secondary

10 file system during the read/write access to the secondary file system between the time of

11 the first snapshot copy and the second snapshot copy; and

12   terminating read/write access to the secondary file system, and once the changes

13 made to the secondary file system have been written into the primary file system,

14 restarting the read/write access to the primary file system and asynchronous remote copy

15 of changes made to the primary file system being copied to the secondary file system.

16

17   9.   The method as claimed in claim 8, wherein the asynchronous remote copy

18 of changes made to the primary file system being copied to the secondary file system

19 includes using the Internet Protocol to transmit the changes made to the primary file

20 system over a data network between the primary site and the secondary site.

21

22   10.   The method as claimed in claim 8, wherein the asynchronous remote copy

23 of changes made to the secondary file system since the second snapshot copy being

1   copied to the primary file system includes transmitting changes made to the secondary

2   file system over a first IP pipe from the secondary site to the primary site, and which

3   further includes transmitting changes made to the secondary file system between the first

4   snapshot copy and the second snapshot copy over a second IP pipe from the secondary

5   site to the primary site, and wherein the transmission of the changes made to the

6   secondary file system over the first IP pipe is concurrent with the transmission of the

7   changes made to the secondary file system over the second IP pipe.

8

9   11.   In an asynchronous remote copy system in which changes made to data

10 blocks of a primary file system at a primary site are transmitted to a secondary file system

11 at a secondary site, the primary site storing a list of the data bocks that have been changed

12 in the primary file system, a method of recovery from a disruption at the primary site,

13 said method comprising:

14   accessing the list of the data blocks that have been changed in the primary file

15 system to restore the primary file system to a prior state at a restart point, the prior state at

16 the restart point including changes made to the primary file system that have been

17 transmitted to the secondary site, the primary file system being restored by determining

18 from the list the data blocks that have been changed in the primary file system since the

19 restart point, and obtaining from the secondary site the data existing at the time of the

20 restart point in the data blocks that have been changed in the primary file system since the

21 restart point, and writing into the primary file system the data existing at the time of the

22 restart point in the data blocks that have been changed in the primary file system since the

23 restart point.

12.   The method as claimed in claim 11, which includes the secondary site responding to the disruption by making a snapshot copy of the secondary file system at the restart point once all of the changes to the primary file system that have been transmitted to the secondary file system have been written into the secondary file system, and wherein the data existing at the time of the restart point in the data blocks that have been changed in the primary file system since the restart point are obtained from the snapshot copy at secondary site.

13.   The method as claimed in claim 11, which further includes the secondary site activating the secondary file system for read/write access once all of the changes to the primary file system that have been transmitted to the secondary file system prior to the disruption have been written into the secondary file system.

14.   The method as claimed in claim 11, which further includes the secondary site responding to the disruption by activating the secondary file system for read/write access, and wherein the state of the primary file system at the restart point is the state of the secondary file system when the secondary file system is activated for read/write access.

15.   The method as claimed in claim 14, which includes the secondary site keeping a record of changes made to the secondary file system since the restart point, and once the primary site is operative and after writing into the primary file system the data

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1 existing at the time of the restart point in the data blocks that have been changed in the

2 primary file system since the restart point, writing the changes made to the secondary file

3 system since the restart point into the primary file system.

4

5 16. The method as claimed in claim 14, which includes the secondary site

6 keeping a record of changes made to the secondary file system since the restart point, and

7 once the primary site is operative, beginning at an intermediate point replication of

8 changes made to the secondary file system, and after writing into the primary file system

9 the data existing at the time of the restart point in the data blocks that have been changed

10 in the primary file system since the restart point, copying changes made to the secondary

11 file system since the restart point and up to the intermediate point into the primary file

12 system.

13

14 17. The method as claimed in claim 16, which includes beginning playback of

15 the replicated changes made to the secondary file system into the primary file system

16 once the changes made to the secondary file system since the restart point and up to the

17 intermediate point have been copied to the primary file system.

18

19 18. The method as claimed in claim 17, which includes ending read/write

20 access to the secondary file system thereby terminating the replication of changes made

21 to the secondary file system, and once all of the changes made to the secondary file

22 system have been played back into the primary file system, the primary site restarts the

1   transmission of changes made to data blocks of the primary file system to the secondary

2   file system.

3

4   19.   An asynchronous remote copy system comprising a primary data storage

5   system and a secondary data storage system, the primary data storage system having a

6   primary file system and the secondary data storage system having a secondary file

7   system, the primary data storage system being programmed for read/write access to the

8   primary file system and asynchronous remote copy of changes made to the primary file

9   system being copied to the secondary file system,

10   wherein the secondary data storage system is programmed to respond to the

11   primary data storage system becoming inoperative during the asynchronous remote copy

12   of changes made to the primary file system being copied to the secondary file system by

13   beginning read/write access to the secondary file system, making a snapshot copy of the

14   secondary file system at the beginning of read/write access to the secondary file system,

15   and keeping a record of changes made to the secondary file system during the read/write

16   access to the secondary file system; and

17   wherein the primary data storage system and the secondary data storage system

18   are programmed for recovery when the primary data storage system becomes operative

19   by using the snapshot copy to restore the primary file system to the state of the secondary

20   file system existing when read/write access of the secondary file system was begun, and

21   then writing into the primary file system the changes made to the secondary file system

22   during the read/write access to the secondary file system, terminating read/write access to

23   the secondary file system, and once the changes made to the secondary file system have

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1 been written into the primary file system, restarting read/write access to the primary file

2 system and asynchronous remote copy of changes made to the primary file system being

3 copied to the secondary file system.

4

5 20. The asynchronous remote copy system as claimed in claim 19, wherein the

6 primary data storage system is programmed to perform the asynchronous remote copy of

7 changes made to the primary file system being copied to the secondary file system by

8 using the Internet Protocol to transmit the changes made to the primary file system over a

9 data network between the primary data storage system and the secondary data storage

10 system.

11

12 21. The asynchronous remote copy system as claimed in claim 20, wherein the

13 secondary data storage system is programmed to respond to the primary data storage

14 system becoming operative by transmitting over a first IP pipe changes having been made

15 to the secondary file system during the read/write access to the secondary file system

16 prior to the primary data storage system becoming operative, and concurrently

17 transmitting over a second IP pipe changes having been made to the secondary file

18 system during read/write access to the secondary file system after the primary data

19 storage system becomes operative.

20

21 22. The asynchronous remote copy system as claimed in claim 19, wherein the

22 state of the secondary file system existing when read/write access of the secondary file

23 system was begun is a prior state of the primary file system existing before the primary

1   data storage system became inoperative, and wherein the primary data storage system is

2   programmed to keep a list of blocks that have been changed in the primary file system

3   during the read/write access to the primary file system, and to restore the primary file

4   system to the state of the secondary file system existing when read/write access of the

5   secondary file system was begun by accessing the list of blocks that have been changed

6   in the primary file system during the read/write access to the primary file system to

7   determine the blocks that have been changed in the primary file system since said prior

8   state of the primary file system, and copying from the snapshot copy to the primary file

9   system the blocks that have been changed in the primary file system since said prior state

10   of the primary file system.

11

12   23.   An asynchronous remote copy system comprising a primary data storage

13   system and a secondary data storage system, the primary data storage system having a

14   primary file system and the secondary data storage system having a secondary file

15   system, the primary data storage system being programmed for read/write access to the

16   primary file system and asynchronous remote copy of changes made to the primary file

17   system being copied to the secondary file system,

18   wherein the secondary data storage system is programmed to respond to the

19   primary data storage system becoming inoperative during the asynchronous remote copy

20   of changes made to the primary file system being copied to the secondary file system by

21   the secondary data storage system beginning read/write access to the secondary file

22   system, and

1   wherein the primary data storage system and the secondary data storage system

2   are programmed to respond to the primary data storage system becoming operative by

3   synchronizing the primary file system to the secondary file system by beginning

4   asynchronous remote copy of changes made to the secondary file system being copied to

5   the primary file system, making a snapshot copy of the secondary file system at the

6   beginning of the asynchronous remote copy of changes made to the secondary file system

7   being copied to the primary file system, synchronizing the primary file system to the

8   snapshot copy of the secondary file system, and once the primary file system has been

9   synchronized to the snapshot copy of the secondary file system, terminating read/write

10   access to the secondary file system and completing the asynchronous remote copy of

11   changes made to the secondary file system being copied to the primary file system; and

12   once the asynchronous remote copy of changes made to the secondary file system has

13   been completed, restarting read/write access to the primary file system and asynchronous

14   remote copy of changes made to the primary file system being copied to the secondary

15   file system.

16

17   24.   The asynchronous remote copy system as claimed in claim 23, wherein the

18   primary data storage system is programmed to perform the asynchronous remote copy of

19   changes made to the primary file system being copied to the secondary file system by

20   using the Internet Protocol to transmit the changes made to the primary file system over a

21   data network between the primary data storage system and the secondary data storage

22   system.

23

25. The asynchronous remote copy system as claimed in claim 23, wherein the secondary data storage system is programmed to perform the asynchronous remote copy of changes made to the secondary file system being copied to the primary file system by transmitting changes made to the secondary file system over a first IP pipe from the secondary data storage system to the primary data storage system, and the secondary data storage system is programmed to synchronize the primary file system to the snapshot copy of the secondary file system by transmitting changes made to the secondary file system over a second IP pipe from the secondary data storage system to the primary data storage system, wherein the transmission of the changes made to the secondary file system over the first IP pipe is concurrent with the transmission of the changes made to the secondary file system over the second IP pipe.

26. An asynchronous remote copy system comprising a primary data storage system and a secondary data storage system, the primary data storage system having a primary file system and the secondary data storage system having a secondary file system, the primary data storage system being programmed for read/write access to the primary file system and asynchronous remote copy of changes made to the primary file system being copied to the secondary file system,

wherein the secondary data storage system is programmed to respond to the primary data storage system becoming inoperative during the asynchronous remote copy of changes made to the primary file system being copied to the secondary file system by beginning read/write access to the secondary file system, making a first snapshot copy of the secondary file system at the beginning of read/write access to the secondary file

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1   system, and keeping a record of changes made to the secondary file system during the

2   read/write access to the secondary file system;

3   wherein the secondary data storage system is programmed to respond to the

4   primary data storage system becoming operative by making a second snapshot copy of

5   the secondary file system, and beginning asynchronous remote copy of changes made to

6   the secondary file system since the second snapshot copy being copied to the primary file

7   system; and

8   wherein the primary data storage system and the secondary data storage system

9   are programmed for using the first snapshot copy to restore the primary file system to the

10 state of the secondary file system existing when read/write access of the secondary file

11 system was begun, and then writing into the primary file system the changes made to the

12 secondary file system during the read/write access to the secondary file system between

13 the time of the first snapshot copy and the second snapshot copy, and terminating

14 read/write access to the secondary file system, and once the changes made to the

15 secondary file system have been written into the primary file system, restarting read/write

16 access to the primary file system and asynchronous remote copy of changes made to the

17 primary file system being copied to the secondary file system.

18

19   27.   The asynchronous remote copy system as claimed in claim 26, wherein the

20 primary data storage system is programmed to perform the asynchronous remote copy of

21 changes made to the primary file system being copied to the secondary file system by

22 using the Internet Protocol to transmit the changes made to the primary file system over a

1   data network between the primary data storage system and the secondary data storage

2   system.

3

4   28.   The asynchronous remote copy system as claimed in claim 26, wherein the

5   secondary data storage system is programmed to perform the asynchronous remote copy

6   of changes made to the secondary file system since the second snapshot copy being

7   copied to the primary file system by transmitting changes made to the secondary file

8   system since the second snapshot copy over a first IP pipe from the secondary data

9   storage system to the primary data storage system, and the secondary data storage system

10   is programmed to transmit the changes made to the secondary file system during the

11   read/write access to the secondary file system between the time of the first snapshot copy

12   and the second snapshot copy over a second IP pipe from the secondary data storage

13   system to the primary data storage system, wherein the transmission of the changes made

14   to the secondary file system over the first IP pipe is concurrent with the transmission of

15   the changes made to the secondary file system over the second IP pipe.

16

17   29.   An asynchronous remote copy system comprising a primary data storage

18   system and a secondary data storage system, the primary data storage system having a

19   primary file system and the secondary data storage system having a secondary file

20   system, the primary data storage system being programmed for read/write access to the

21   primary file system and asynchronous remote copy of changes made to the primary file

22   system being copied to the secondary file system, the primary data storage system storing

23   a list of the data bocks that have been changed in the primary file system;

1   wherein the primary data storage system and the secondary data storage system

2   are programmed for recovering from a disruption in the asynchronous remote copy of

3   changes made to the primary file system being copied to the secondary file system by

4   accessing the list of the data blocks that have been changed in the primary file system to

5   restore the primary file system to a prior state at a restart point, the prior state at the

6   restart point including changes made to the primary file system that have been

7   transmitted to the secondary data storage system, the primary file system being restored

8   by determining from the list the data blocks that have been changed in the primary file

9   system since the restart point, and obtaining from the secondary data storage system the

10   data existing at the time of the restart point in the data blocks that have been changed in

11   the primary file system since the restart point, and writing into the primary file system the

12   data existing at the time of the restart point in the data blocks that have been changed in

13   the primary file system since the restart point.

14

15   30.   The asynchronous remote copy system as claimed in claim 29, wherein the

16   secondary data storage system is programmed to respond to the disruption by making a

17   snapshot copy of the secondary file system at the restart point once all of the changes to

18   the primary file system that have been transmitted to the secondary file system have been

19   written into the secondary file system, and wherein the secondary file system is

20   programmed to obtain from the snapshot copy the data existing at the time of the restart

21   point in the data blocks that have been changed in the primary file system since the restart

22   point.

23

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31.   The asynchronous remote copy system as claimed in claim 29, wherein the secondary data storage system is programmed to activate the secondary file system for read/write access once all of the changes to the primary file system that have been transmitted to the secondary file system prior to the disruption have been written into the secondary file system.

32.   The asynchronous remote copy system as claimed in claim 29, wherein the secondary data storage system is programmed to respond to the disruption by activating the secondary file system for read/write access, and the state of the primary file system at the restart point is the state of the secondary file system when the secondary file system is activated for read/write access.

33.   The asynchronous remote copy system as claimed in claim 32, wherein the secondary data storage system is programmed for keeping a record of changes made to the secondary file system since the restart point, and wherein the primary data storage system is programmed for writing into the primary file system the data existing at the time of the restart point in the data blocks that have been changed in the primary file system since the restart point and then writing the changes made to the secondary file system since the restart point into the primary file system.

34.   The asynchronous remote copy system as claimed in claim 32, wherein the secondary data storage system is programmed for keeping a record of changes made to the secondary file system since the restart point, and for responding to the primary data

storage system becoming operative after the disruption by beginning at an intermediate point replication of changes made to the secondary file system, and copying to the primary data storage system changes made to the secondary file system since the restart point and up to the intermediate point.

35.   The asynchronous remote copy system as claimed in claim 34, wherein the primary data storage system is programmed to write into the primary file system the changes made to the secondary file system since the restart point and up to the intermediate point, and then begin playback of the replicated changes made to the secondary file system into the primary file system.

36.   The asynchronous remote copy system as claimed in claim 35, wherein the primary data storage system is programmed to restart read/write access to the primary file system and asynchronous remote copy of changes made to the primary file system being copied to the secondary data storage system once all of the changes made to the secondary file system have been played back into the primary file system.